Penetrating missile injury to the heart without pericardial effusion: The immaculate bullet and the ‘Iron Man’ injury

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CENTRAL MESSAGE

This report describes the management of an unusual case of an asymptomatic bullet lodged in the intraventricular septum with a trans-mediastinal course.

CENTRAL PICTURE LEGEND

Computed tomography, sagittal reformat. Arrow shows bullet in the interventricular septum.

ABSTRACT

Penetrating missile injury to the heart is generally a mortal injury with 90% of patients failing to arrive to a medical facility. Hemorrhage typically ensues resulting in a significant pericardial effusion easily recognizable on computed tomography, chest x-ray or sonography for those patients who survive transport to a hospital. We are aware of four reports of a penetrating gunshot wound to the heart without pericardial effusion. We report a fifth. Given the unusual nature of the case and scant literature to guide management decisions we felt our experience with this case might be of interest.

CASE PRESENTATION

A 34-year-old man was air-lifted to our hospital after sustaining gunshot wounds to the mid-back and left buttock. He had been intubated and after a chest x-ray (CXR) revealed a left-sided effusion a chest tube had been placed with a return of 80 mL of blood by report. After transport, he was hemodynamically stable without ongoing drainage from the thoracostomy tube. His exam was notable for penetrating wounds to the mid-back left of midline. His laboratory values were unremarkable. His urine toxicity was positive for amphetamine and fentanyl. An extended focused assessment with sonography in trauma exam was without evidence of pericardial effusion. His CXR demonstrated a metallic density within the cardiac silhouette (figure 1a). The computed tomography scan showed the metallic density embedded in the interventricular septum (figure 1b-d).
Given the unclear trajectory and the potential for occult injuries, the patient was taken to the operating room where upper endoscopy and bronchoscopy ruled out esophageal and tracheobronchial injuries respectively. A trans-esophageal echocardiogram showed left ventricular ejection fraction of 35-40% without wall motion abnormality or valvular pathology. It also showed the metallic density in the interventricular septum about midway to the apex of the left ventricle projecting into the left ventricle (figure 1). Due to potential dislodgement and embolization, we felt removal was prudent.

Through a median sternotomy we appreciated a 1-2 mm defect in the anterior pericardium. There was a similar defect in the left-sided parietal pleura. There was scant blood-tinged pericardial fluid and a 1 mm puncture between the left anterior descending coronary artery (LAD) and vein midway to the apex with associated myocardial bruising. The patient was heparinized, placed on bypass and the heart arrested. We made an incision in the left ventricle parallel to the LAD but several centimeters lateral, entered the ventricle and found the projectile emerging from the interventricular septum, it was grasped with a Rongeur and passed off the field (video). We irrigated but did not debride the tract to avoid a potential ventricular septal defect. The septal injury and the ventriculotomy were repaired using several 4-0 polypropylene, pledgeted, horizontal mattress sutures. Because we had made the incision remote from the LAD we were able to close it without kinking the vessel (figure 2). The heart was then reanimated, and separated from bypass without difficulty. A careful examination of the left chest ruled out any injury. The postoperative trans-esophageal echocardiogram showed unchanged ventricular function and no evidence of either a ventricular-septal defect or retained metallic objects. The patient’s other wounds were managed medically, he had an uneventful recovery, was discharged four days later and was doing well at last follow-up one month after discharge.

**Ethics statement**

Informed consent for publication of the case details and clinical images was obtained from the patient. We submitted the paper to our Institutional Review Board but they determined that approval was not required because no interaction or intervention with the patient occurred.
COMMENT

In previously reported cases of a missile penetrating the heart without a pericardial effusion the bullet also
lodged in the interventricular septum and the patients were also hemodynamically stable [1-4]. Two were
managed with delayed surgical intervention and in both cases the bullet was approached through a right
atriotomy and found lodged in the membranous septum [1, 4] while the other two were managed non-
operatively [2, 3]. The lack of a pericardial effusion in all the cases is likely due to the fact that the
missiles did not penetrate a cardiac chamber or injury a significant coronary artery branch.

Our case raises two questions: whether to remove the projectile in a hemodynamically stable
patient and, if so, how? Potential complications of non-operative management include imminent or
delayed embolization, gradual erosion outside the heart with ensuing hemorrhage, erosion through the
septum causing a ventricular septal defect and pericarditis resulting in patient discomfort and possibly
constrictive physiology. Risks of operative intervention include exacerbation of bleeding from
concomitant non-thoracic injuries due to the need for systemic anticoagulation as well as the sundry risks
of the operation itself. The fictional Tony Stark from the Iron Man movie franchise was injured by
shrapnel penetrating his heart anteriorly, creating a somewhat analogous scenario. Happily, for him, an
industrious and available colleague developed an ‘arc reactor’ and an electromagnet that kept the shrapnel
immobile. We in the surgical community are less fortunate and therefore decisions must be made. In a
patient who has no cerebral or abdominal injuries for which systemic anticoagulation would be
catastrophic and who is not a prohibitive baseline risk we favor removal of the missile. In patients with
associated injuries delayed intervention should be considered.

Approaches to bullets lodged in the ventricular septum include through the left or right atrium or
the aorta with retraction of the mitral [5], tricuspid [1, 6] and aortic valves (not reported) respectively. Or
directly through the right [6] or left ventricle (also not previously reported). Guided by the
echocardiogram, we felt it would be easier to approach from the left side. Due to the location mid-way
towards the apex we felt exposure through the mitral valve would be challenging and therefore went
through the left ventricle. We also considered approaching the bullet through the aortic valve (with the advantage being avoidance of a ventriculotomy) but we felt exposure would be difficulty given the mid-ventricle location somewhat remote from where we would have made the aortotomy. One consideration would have been to place a 5 mm 30 degree thoracoscope through the aortic valve to visualize the location but removal through the aortic valve with the scope and another instrument to grasp the bullet would have been challenging and risk injury to the valve. We considered making the incision in the apex of the left ventricle rather than in the mid-ventricle to avoid ventricular dysfunction but given the mid-septal location we thought that exposure would be inadequate. It is unclear why the patient had compromised left ventricular function on arrival; possibilities include chronic amphetamine abuse or stunning from the trauma to the heart; an unrelated, pre-existing, non-ischemic cardiomyopathy is less likely.

Given the entry wound on the back and the defects in the left pleura and anterior pericardium the bullet likely passed through the posterior mediastinum into the left chest and ricocheted into the heart between the LAD and associated vein without injuring either vessel, the airway, the esophagus, the spine, the lung parenchyma or hilum and generating minimal blood loss. Almost the stuff of Hollywood legend.

REFERENCES


FIGURES

1. Chest x-ray and computed tomography scan arrival to our Emergency Department.
Figure 2. Repair of ventriculotomy and projectile passed off the field.
FIGURE LEGENDS

1. (A) Antero-posterior, supine portable chest x-ray. Thick black arrow: bullet, thin black arrow: external marker on back representing abrasions, thick white arrow: open paper clip marking wound on back consistent with ballistic injury. Computed tomography scan in the sagittal (B), axial (C) and coronal (D) projections. In each panel the black arrow indicates the projectile. In panel B the white arrow points to air and stranding in the posterior mediastinum. In panel C the white arrow points to atelectasis and consolidation of the left lower lobe. Of note there is no pericardial effusion evident.

2. Intraoperative image oriented with the apex of the heart at the bottom of the screen. Dashed black line indicates course of left anterior descending coronary artery. White arrow indicates repair. Insert shows what appears to be a 9 mm bullet passed off the field.

VIDEO LEGEND

Removal of missile from interventricular septum.